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RELATIONS OF THE MAN OF SCIENCE TO THE COMMUNITY.

ADDRESS

TO THE

AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE,

BY

BENJAMIN APTHORP GOULD,

ON RETIRING FROM THE OFFICE OF PRESIDENT.

AUGUST 20, 1869.

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ADDRESS.

MR. PRESIDENT AND GENTLEMEN OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT of SCIENCE.

THE usage, and even the fundamental law, of this Association entail upon its retiring President a duty which he may not evade: that of delivering at the meeting following his term of official service, a formal address. Although the fulfilment of this duty is but a very inadequate return for the honor which your partiality has conferred upon him, still it is not without its embarrassments, not the least of which is the apprehension of comparison with the utterances on previous occasions by great and honored philosophers who have presided over your meetings. Many of their words were spoken for the children's children of those who listened. Reaching the very souls of those who heard at the moment, they became there endowed with new life and energy, each recipient becoming a center of emanation for what in them was true and important; while they survive upon the printed page for transmission in letter as well as spirit to unborn generations.

Would that I could offer such precious thoughts or incentives for your acceptance. How can I presume to speak as a successor of Bache, Henry, Agassiz and the other great investigators to whom in turn you have confided the guidance of the Association. Yet as their follower, in another sense, I may address you, for I believe that the few ideas which I propose laying before you would find with them approval and indorsement.

With your permission I will speak of the position of the scientific investigator in the community; of the duties incumbent upon him, and of what he may rightfully expect in return, under the present relations of civilized and educated communities; of the peculiar opportunities and restrictions in the United States today; of the obstacles which beset the path of the laborer in scientific fields; and of the results which he may be justified in anticipating as the reward of patient, unfaltering, conscientious effort in his high vocation.

We are accustomed to regard ourselves as belonging to a new country, and to palliate in our own hearts, even if not openly, our intellectual short-comings and our deficiencies in learning or culture, by this plea. And just as men who have attained eminence, notwithstanding an absence of early opportunities, are often accustomed to glory in this want of advantages, as though it had been a merit rather than a misfortune, —judging themselves always by a relative, instead of an absolute, standard,—so we American lovers of science are too much inclined to take note of the difficulties against which we have struggled or are struggling, rather than of the actual level which we have attained by the effort. Of course there is much to extenuate in this proclivity; how much, you all know. The want, until a recent date, of books of reference; the want of access to such implements of research as are beyond the reach of most private men; the want of time and energy to spare from the grand "struggle for existence;" and above all, the want of competent scientific counselers and guides for the beginner in scientific research; all these are well known to those of you who have attained an age at all approaching the meridian of life. Before the omniscient Judge, they will surely be credited to each individual in the great account. But if we consider not the individuals but the people, and hold the community responsible for its collective failures, while we give it credit for its collective achievements, in the intellectual field, I am sometimes apprehensive that we are given to pluming ourselves too much, and to estimating our progress rather by the number of obstacles which we know to have been surmounted, than by the mile-stones which have been left behind. Communities have merits and failings, as individuals have;

they are but the integral of their many constituent individuals; and among our national failings can scarcely be counted that of judging ourselves too harshly. Our aim should not be to overcome difficulties, except so far as this is a necessary means of advance; it is progress, toward which our efforts should be directed, and if the obstacles are serious, we have, as a people, no right to credit merely for having surmounted them, provided we possess, and do not employ, the power to remove them. Can the intellectual standing and rank of a nation be fairly measured by the highest achievements of its ablest and most devoted men, if so be that these men or their deeds are not the legitimate fruit of the tendencies and influences at work, but, on the contrary, are exceptional cases, which have maintained their existence and even blossomed out by virtue of the humanity that was in them, notwithstanding hindrances and discouragements?

Two hundred and forty years have passed since our ancestors sought the wooded hills, the sheltered valleys, and broad meadow lands which skirt the coast of Massachusetts Bay, and amid which we are assembled here. Less than forty miles from this spot, landed the stern pilgrims of Plymouth, eight years earlier. Ten or twelve years earlier still had been founded the English settlement at Jamestown; but it has been the established verdict of history that from the region where we now are, from within a circle not thirty miles in radius around yonder metropolis, may the spread of arts, letters and science be traced throughout this broad land. Within six years from the arrival of the first settlers of the Massachusetts Bay, they voted to establish a college, and appropriated therefore a sum "equal to a year's rate of the whole colony." In the ensuing year they changed the name of the town in which they placed it from Newton to Cambridge, "a grateful tribute to the trans-Atlantic literary parent of many of the first emigrants, and indicative of the high destiny to which they intended the institution they were establishing should aspire." A single year later, John Harvard, a graduate of Emanuel College, Cambridge, bequeathed to the incipient university his library and one-half his fortune, amounting to nearly twice what the Colony had voted. "The example of Harvard," says President Quincy, "was like an electric spark, falling upon materials of a sympathetic nature, exciting immediate action and consentaneous energy. The magistrates caught the spirit and led the way by a subscription among themselves of two hundred pounds, in books for the library. The comparatively wealthy followed with gifts of twenty and thirty pounds. The needy multitude succeeded like the widow of old, 'casting their mites into the treasury.'"

These facts I recall to your memories, to show the length of time during which our national culture has been receiving shape and character. For two centuries and a third, at least, the characteristic, mental and intellectual tendencies of this people have been forming themselves. Our fathers brought with them such culture as the best seminaries of their native land could give; they represented the best intellect of the several classes of the mother country. The professional, the titled, the mechanic and the agricultural classes of New-England were severally of an intellect and culture much above the average of the same classes in old England, whence they came. The standards of scholarship, of science and of art, which they brought across the seas, were the same which they left behind. For the intellectual progress of the world since then, this community has owed its proportionate share, to be reckoned in the joint ratio of its population and of its initial advantages.

True, our people has had the forest, the desert and the red man to vanquish; it has had the social problems to solve, first of a protestant hierarchy, then of independence of all priestcraft, kingcraft and feudalism, and finally of equality before the law, for all who wear the form of man and are created in the image of God. True, it has had its share of trials from foes without and traitors within, and has had the strong bonds of hereditary political and intellectual dependence to burst. True, it has already given to the world many a masterwork, in the arts of peace and the arts of war; the steamboat, the cotton-gin and the sewing machine; the practical application of the electric telegraph, and the means of its printed record; the most perfect forms yet attained for the steam-engine and the steam-boiler; the most powerful ordnance and the most impregnable vessels; the telescopes of Clark and Fitz, the microscopes of Spencer and Tolles, and the means of annihilating pain. True, it has planted the starry flag upon the Antarctic continent and by the Polar sea, and has given to history many a name of the wise and good, whose blessed memory can never be hemmed in by oceans. Heaven forbid that any son of America should shut his eyes to these subjects of honest pride, or to a host of others like them, which I have no need to recount! If love of country be a virtue, assuredly it is not a difficult one for us to exercise. But what I would now say is, that, whatever may be the claims of our country to have done her part in the furtherance of civilization so far as depends upon the solution of high political problems and upon advancement in the arts, her contributions to science have not kept pace with these; nor indeed with those of several European nations, which have had to contend against obstacles quite comparable in magnitude with our own, even though of a totally different nature. France, torn asunder by frenzied convulsions and internal throes, such as no other civilized nation has ever been called on to endure, — Germany, trampled under foot again and again by foreign invaders, civil strife and domestic oppression, — Russia, lately emerged from Asiatic barbarism and contending at once against the Turk, the Tartar and the western foe, — have they not had their share of hindrances to scientific progress, great even if inferior to those offered by the forest and the savage? Yet it would ill beseem us to invite a comparison with them in any department of science, physical or natural. Equate out the names of a very few men on each side, wherever this seem possible, and what an overwhelming preponderance would then throw the Western scale aloft.

"Two hundred and forty years," I hear some one say, "what are they in the development of a nation, or of its scientific character? Twenty-five centuries have passed since Thales predicted an eclipse of the sun; nineteen, since Sosigenes reformed the calendar for Julius Cæsar; fourteen hundred years have rolled over the University of Bologna. What to you occidentals seems a hoary antiquity, is a mere yesterday for the dweller by the Tiber, the Thames, the Seine, the Danube or the

Rhine." Be it so! Yet Hans Lippersheim's first suggestion of a telescope was eighteen months after Newport had sailed up the James river with his infant colony. The idea of a logarithm was then not born: Napier and Briggs were names unknown to fame. The oaks and beeches had been cleared from these hills, and our ancestors had built their rustic homes, at the time when Galileo was tortured into abjuring the profane doctrine that the earth moved, and not the sun. When Harvard endowed the college that bears his name, there was no such thing as a barometer or a thermometer. It is within these very two hundred and forty years that modern science has come into existence, and the world's intellect been turned from speculation to investigation. It is within this period that our implements of research have been devised, that the air-pump, the electrical machine and the clock have been invented, that every public chemical laboratory, every astronomical or physical observatory, and every academy of sciences has been founded. Boston had been settled when Keppler died. The grandchildren of the original colonists of Plymouth and the Massachusetts Bay were born, when the law of universal gravitation was first proclaimed by Newton.

Therefore it is that we must confess our scientific progress to have been far inferior to that of several European nations. And I fear that the confession might truthfully be made much broader, and include our progress in all purely intellectual studies, which hold forth no promise of immediate utility in promoting physical well-being or material convenience. If this is true, my friends, it is time that it should be so no longer. And before you, the declared lovers of science,—in this Association formed to promote her welfare and advancement,—here in the earliest seat of that colony, whence has geographically radiated what of culture and of science our country has possessed,—I would fain say some few words which, however crude or ill-arranged, might find a congenial soil within your hearts—to bear fruit, perhaps, when all of us have disappeared from the stage—and which might aid, in however small a degree, to avert the day when the highest recognized aims shall be toward material prosperity, rather than toward intellectual development and progress.

There must be in every community men specially endowed with scientific tastes and impulses. In most cases such innate tendencies accompany especial gifts in the same direction, and although in the infinitely varied scheme of nature, this is not always the case, yet the exceptions are few, and the incentives to exertion, which such tastes supply, do much toward atoning for the lack of original power. Wherever positions of honor or emolument are available for the man of science, these become objects of ambition or of greed to another class of men who aspire to them as ends to be attained and not as means of scientific progress. It is to such that Schiller referred when he said of science,

> "Einem ist sie die hohe, die himmlische Göttin; dem andern
> Eine tüchtige Kuh, die ihn mit Butter versorgt." *

Between these two classes it is impossible to draw a sharply defined line. They shade into one another by such imperceptible gradations, that many a man might be unable, in his strictest communings with himself, to decide as to which he himself belonged. Then there is an intermediate class, whom circumstance guides into the scientific path and who are endowed with a versatility which enables them effectively to follow out any career to which they earnestly devote themselves.

Now the social problem here evidently is, so to order the influences and attune the public sentiment in the community as to allow the ablest minds to labor in those fields for which they are best adapted, and to guide the most versatile, so far as possible, into such channels that their energies may promote the highest welfare of society.

The magnitude of the class of scientific men in any community is clearly dependent, to a very great extent, upon the intellectual condition of that community. Probably no civilized society, totally devoid of a scientific element, ever did or ever will exist. In ancient Rome its amount appears to have been a minimum, yet in ancient Greece it was far otherwise; whence we may infer that the fine arts and *belles-lettres* are in themselves neither conducive nor antagonistic to science, in any marked degree. At all times and places there have been some in whom the divine fire burned; and so it doubtless ever will be. Such could no more be turned from their high instinct to discover causes and laws, than the mountain torrent from its course toward the sea. Yet how few are these, although they have never failed to pass the torch from age to age! Even in the days of Roman dominion, Africa nursed the embers of the sacred flame; and swarthy Arabs and Moors, with here and there a silent monk, guarded it through the dark ages; ages replete with classic lore, with wondrous art, with barbaric luxury, yet devoid of science, except in the secret guardianship of those who dared not betray their priceless yet mysterious possession.

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* "She is the high, the heavenly Goddess to one; to another
But a convenient cow, that gives him his butter and cheese."

To such men the civilization of today permits freedom of inquiry and of utterance, at least, and awards a certain modicum of public recognition and respect, limited, it is true, not by the good will of the community, but by its means of appreciating the character and scope of their labors. These are the men, nevertheless, to whom indirectly the world owes its material progress, although the intermediate steps, between their researches and the ingenious inventions by which their results are practically utilized, are rarely traced, even by those who reap the harvest. Yet it is not for the sake of material progress that they have toiled; this is simply the world's recompense for having harbored them. *Sic vos non vobis mellificatis, aves.* These are the men who toil on in their lofty studies, seeking the truth for its own sake, drawn as by some resistless magnetism, and working even better than they know. Poverty cannot suppress the instinct; ridicule cannot prevent its exercise; persecution cannot deter from the utterance of its results.

This scanty class constitutes the minimum number of the followers of science for any community. The additional number is greater or less according to the amount of personal sacrifice requisite for following the inborn impulse — since the intensity of this impulse varies in every degree, — or according to the temptations offered for joining the ranks of those who adopt science as a business. It is easy to see that there is danger to the intellectual progress of the community at each extreme. Where the votary of science must sacrifice all to follow her, her welfare is scarcely more imperiled than where the guardianship of her interests, and the means of extending her domain, are confided to the hands of those who would make of her a servant, and not a sovereign.

By an unhappy, though perhaps natural, mischance, the English language has had no name for the scientific investigator, nor word to denote his calling. There is no nobler word than philosopher, — lover of knowledge; yet, in the score of centuries since this grand old word has been in use, its meaning, if not perverted, has at least been narrowed and distorted. The French expression, *savant*, has sometimes been pressed into service by those who have felt the want of some appropriate term; but, without undertaking to criticise the aptness of this word, it is most certain that the time has come when our own language demands some name for the class of men who give their lives to scientific study. Therefore it was, that twenty years ago I ventured to propose one, which has been slowly finding its way to general adoption; and the word *scientist*, though scarcely euphonious, has gradually assumed its place in our vocabulary. Philologically, it is subject to criticism, as being from a Latin root with a Greek termination; but it may share this censure with many another word which has become an integral part of the language, and for a needful and helpful idea surely a poor word is better than no word at all. I will, therefore, not hesitate to employ it, and will briefly consider the characteristics of the scientist, and his position in the community.

It would be inappropriate here to undertake any philosophic discussion of the position which the scientist should occupy in an ideal or a well-ordered society, or of the duties imposed on him by his assumption of the priesthood, as an interpreter and expounder of the Divine word written upon the tablets of the material universe. Such course of inquiry would imply, as its basis, a determination of the reciprocal duties of all members of society, whatever their calling; and this involves, in its turn, the deepest questions of political economy and social philosophy. We must take certain principles for granted, and among them, this; — that civilized society is an organic body, of which each member is, in spite of himself, dependent upon the rest, and exerts a corresponding influence in return. The many-sided culture of a normal community is the resultant of the varied capacities, culture and efforts of numerous individuals, no one of whom could attain the highest grade of usefulness in several diverse departments. It depends upon the relative number and variety of the ablest and most cultivated members, conjointly with the influence they exert. Human science and art have, in the progress of our race, advanced far beyond the comprehension of any individual. An equal culture in many directions is synonymous with superficiality in all, and an "admirable Crichton" is today simply a ridiculous object. We cannot well escape the conclusion that — so far as is compatible with that general education of physical and mental faculties and those general attainments which the welfare of others, as well as the amenities of society, require, and which are needful alike for the mental and moral health of the individual — the energies of each one should be consecrated to the development and employment of particular capacities. No thoughtful man can arrive at years of discretion without becoming aware of the character and direction of his mental powers, even though he may be incompetent properly to estimate their relative magnitude; and there can be no reasonable doubt that taste and predilection would afford safe guides for the individual in entering upon his career, were the organism of society fairly developed without distortion by untoward agencies.

Therefore, if the investigation of scientific questions and the discovery of scientific laws is needful or desirable for our race, it becomes the duty of every civilized community to encourage and protect the vocation of the scientist, and it is the duty of those who feel themselves called to this vocation to devote themselves to it with heart and hand. Their commission is from on high. "Freely ye have received, freely give. Provide neither gold nor silver nor brass in your purses, nor scrip for your journey, neither two coats; for the workman is worthy of his meat." If the Creator designs that the race formed in his own image shall discern and comprehend the laws through which he has exerted his creative power; if he means that his wondrous works shall be read by man, upon whom he has bestowed the means and the impulse to read them; if he chooses that our higher capacities shall be cultivated in this world as well as our lower ones; then does he also intend that a class of men shall exist and be maintained, laboring in behalf of all, and devoting their highest energies to intellectual conquests for the race through the study of his works and the interpretation of his laws. Is there any argument, of all those with which the world has been familiar for more than three thousand years in behalf of the sacred ministry of religion, which is not applicable to the ministry of science? If the highest act of the human spirit be to attain to an intimate relation and communion with the Father of spirits, who shall dare discredit that other exalted duty of searching out God through his works, and learning him as he has seen fit to manifest himself to us directly. Unreasonable as it would be to maintain that the word of God, when filtered through many a human tradition and recollection, and translated from language to language after being recorded upon the manuscript, is more surely and emphatically his unperverted word than is that fresh from his own fingers, "written all over the earth, written all over the sky;" how much more so would it be to maintain, that the former, but not the latter, needs a body of investigators. Far be it from me to imply, however indirectly, that the reverse is true—that the culture of the intellect should take precedence of that of the religious faculties—that the most elevated regions of converse with the Deity as known through his noblest works, or his profoundest physical laws, could supersede the necessity of communing through the affections and emotions, or the need of relief to the famishing cry of the soul for bread from its Father in Heaven. It might, perhaps, be urged that for the former a priesthood is, and for the latter it is not, indispensable; that for the former the progress of interpretation goes on continuously, while for the latter little remains to be done, other than the exposition and enforcement of what has already been attained; that the former must lead, while the latter is not unlikely to follow, the development of society. But there is no ground for comparison disadvantageous to either class. My argument is that they should stand alike. Both classes are needed to satisfy a deep and insatiable demand; both are imbued with the instinct to provide a supply. Nor are the abnegations and self-sacrifices by which the one has earned the martyr's crown in past days and lasting reverence in the present, without parallel and counterpart in the other.

With what a spirit of grateful recognition of the Almighty's revelation to the scientist in these latter days, may we read the answer to Job out of the whirlwind!

> "Gird up thy loins now like a man, for I will demand of thee, and answer thou me. Where wast thou when I laid the foundations of the earth? Declare, if thou hast understanding. Who hath laid the measures thereof, if thou knowest; or who hath stretched the line upon it? Whereupon are the foundations thereof fastened, or who laid the corner-stone thereof, when the morning stars sang together, and all the sons of God shouted for joy? . . . . . Hast thou entered into the springs of the sea, or hast thou walked in search of the depths? Hast thou perceived the breadth of the earth? declare, if thou knowest it all. Where is the way where light dwelleth, and as for darkness, where is the place thereof? . . . . . Hast thou entered into the treasures of the snow, or hast thou seen the treasures of the hail? Knowest thou the ordinances of heaven? Canst thou set the dominion thereof in the earth? Canst thou lift up thy voice unto the clouds that abundance of waters may cover thee? Canst thou send the lightnings, that they may go, and say unto thee, Here we are?"

Job answered and said: —

> "Behold, I am vile, what shall I answer thee? I will lay mine hand upon my mouth. Once have I spoken, but I will not answer; yea, twice, but I will proceed no farther."

But we might reply: — 'Lord, thou hast revealed unto us all these things. Us also hast thou taken into the counsels of thy creation, for thou hast not deemed thy children unworthy of thy knowledge. The foundations and breadth of the earth and the ordinances of the heavens, the depths of the sea and the way of the light, the treasures of the snow and the sources of the hail, the sending of lightnings to say 'Here we are,' and the lifting of our summons to the clouds that we may have rain; — behold thou hast disclosed them all unto us, thy children!'

The claim of the scientific profession to recognition and support has long been acknowledged by most European nations. Throughout the European continent organizations have been established, and are maintained by the government at very considerable expense, for the one purpose of promoting scientific research; and the individuals composing these organizations are provided with the means of support while laboring to this end. In our own utilitarian country few claims are recognized excepting such as afford a direct personal benefit, which the individual recipients can estimate by some pecuniary standard. Thus the successful investigator in any special department of medical science may reap a rich reward,—so rich indeed as to hold out strong temptations for the surrender of so large a share of his time and energies to the practice of his art, as to leave small opportunity for the farther prosecution of his science. Indeed, when we examine the matter carefully, we shall find that it is only art (*i. e.* the application of principles and laws), for which any practical recognition can be expected in America at present; while science (*i. e.* the discovery and investigation of these laws), even where nominally fostered, receives support only through some of its indirect branches, which more properly belong within the domain of art. In this way medical science in this country is supported only through individual need of the healing art; physical research, only through its most direct application to technology; mathematical investigation, only in so far as it stands in palpable relation to engineering, surveying, or some other practical use; chemistry, as being an important handmaid to manufacture and to metallurgy; astronomy, almost solely as an assistance to navigation. To one considering these unquestionable facts, the parallel case at Niagara presents itself unbidden:—

"The tailor made a single note:
'Gods! what a place to sponge a coat!'"

In recounting these facts, it is without apprehension that they will be scouted, by any educated and thoughtful man not versed in scientific matters, as though they presented the one-sided view entertained by a narrow class of persons, who, from habitual occupation with abstract or general inquiries, have become blinded to the great material interests of society. No doubt the advance of civilization is measurable by the progress of the arts; and especially is our nation charged, as no nation ever was before, with the duty of subjugating nature, and diffusing the arts of civilized life over a continent. No doubt the first instinct of humanity is to provide for its material well-being; and the craving for comfort and luxury is a stimulus at whose bidding the whole world is to be made one family, through the beneficent agencies of commerce. But I do claim, first, that we have reached a stage at which it behooves us to acknowledge a higher aim, as much beyond the commercial and technological as the intellect is beyond the body: that the aim is dictated to us by the Creator through intellectual incentives and opportunities, and that its pursuit is unfailingly rewarded by material recompenses. And, secondly, even if we disregard these considerations altogether, and take into account merely that material progress to which America is devoting all her energies, that it is a narrow and baneful policy which forgets that immediate, direct and palpable influences are not the only ones. Rarely are they even the chief ones.

It would be throwing words away were I to undertake to prove, what you all know already, that scarcely one of all the great advances in the material welfare of humanity would have been made but for the scientist in his closet, whose experiments, researches and generalizations, incited by the love of nature and the aspiration to fathom her laws, have afforded the knowledge which the inventor's fertility of device has made subservient to human welfare. There is no need of balancing the respective merits of the discoverer and the inventor. All will agree that but for the former the latter would be of little use. To be sure it would be false reasoning to maintain that, because valuable inventions are usually due to scientific discoveries, they must be deemed a necessary consequence thereof. Yet experience points to some such conviction; and it would be difficult to point out an important scientific discovery, no matter how abstruse if twenty years old, which has not already conferred some material benefit upon humanity, and which was not itself dependent upon each one of several independent and seemingly isolated previous researches.

It is not then alike the wisest policy and the evident duty of a people already much advanced in material well-being, and ambitious of progress, that it should recognize the debt it owes to science, by courting such opportunities for the future as science may afford? Is it not among its most palpable duties to develop and encourage scientific tastes and investigations, appreciating the material sacrifices which these entail, even under the most favorable circumstances? Is it not discreditable to the civilization of a great people, when scientific ability is habitually stifled or lost, by want of opportunity for its development? Yet a tale might be told, year after year, of earnest and gifted young men compelled by want of bread to abandon the scientific path upon which they had entered with fervor. And if told, I believe it would astonish those whom circumstances have not inured to the facts, as it would mortify and sadden the patriot and the philanthropist. It is to be expected that the pursuit of wealth, or place or power, should have its own reward; the sincere follower of science neither seeks nor expects any of these things. But, unless the idea that a community can have duties and responsibilities, as well as an individual, be preposterous, the competent and willing votary of science is entitled to the means of investigating while he lives, and of living while he investigates. In all this broad land I know of not half a dozen positions, the duties of which may be discharged and a subsistence earned by prosecuting scientific research. What is done is in the intervals of leisure from other labors, which exhaust the energies, but upon which the investigators are dependent for support. The collegiate professor, whose nervous vigor is expended in the task of instilling trite rudiments into the minds of enforced pupils, forms no exception to this statement. And where are the opportunities for those higher teachers who would fain use the blessed privilege of training others for the scientific vocation, and be rewarded by the consciousness that their conceptions, methods, plans and perhaps conjectures, are not to die with them.

It would be far from reasonable to expect that the labors of any considerable proportion of investigators should be severally crowned by large generalizations, or by such discoveries as are subjects of popular appreciation. These are comparatively rare, and have always required the antecedent researches of a series of investigators to whom history is wont to award inadequate acknowledgements. Stones must be quarried and hewn before the edifice can be reared; facts must be gathered before their laws can be discovered; the several laws must be recognized before their generalization can be effected. The function of the scientist is to attain new truths by conquering them from the limitless realm of the unknown, and whether they be brilliant or otherwise, none is too small or insignificant in aspect to deserve his earnest search or joyful welcome. Among the marked characteristics of modern science are its recognition of the value of every observation and experiment,—since there is no one which may not afford a basis or a clew for subsequent advance,—and its appreciation of the services rendered by those who lay the stepping-stones requisite for continued ascent. And in proportion to the scientific development of a community is its relative estimate of the men who do not disdain those minor researches which are yearly becoming more indispensable, yet are unrewarded by popular applause. The science of the nineteenth century is to be sought not in ponderous tomes, but in abundant memoirs. Scientific progress in these days is like that of a besieging army. Little by little miners work beneath the surface; slowly the intrenchments grow to right and left, approaching always, however indirectly; gradually the long circumvallations close around the citadel. Here, ground is gained for a new base of operations; there, is opportunity for striking in a new direction. Through avenues thus laboriously prepared the embattled host advances. At last a point is secured whence the artillery may begin its work. Under cover of this, new approaches are effected, until at last, in the fullness of time, the final charge is made. One brilliant dash, and the stronghold falls. But should the engineers' devices, the miners' toil, the soldiers' labor at the earthworks and the artillerists' service at the guns, all be held cheap, because of our admiration of the gallantry and chivalry that led the decisive onset? So thoroughly has the scientific world been impressed in recent years with the importance of judging researches not by their brilliancy, but by their promise of ultimate usefulness, that the straining after showy results is deemed unworthy and derogatory, while a new and well established fact is welcomed with a more earnest cordiality than the most fascinating hypothesis, or the most plausible conjecture, prior to its verification.

All science is, and must be, to a certain extent, experimental. Even in those branches which from their very nature preclude arbitrary experiment, comparisons of phenomenon with prediction, of observation with computation, supply its place. Methods of discovery, in astronomy and in chemistry or terrestrial physics, differ but little. Keppler's mind was scarcely of a different order, or his processes of a different class, from Faraday's. And, essential as the inductive method may be for a control and criterion of the results attained, few discoveries were ever made by pure induction. Given the result in advance, experiments may be contrived for guiding to it; let us once know that the truth lies in one, and one only, of two divergent directions, and we may think out crucial instances. But such are not usually the circumstances under which discoveries are made; and learning and skill are in general no more necessary for disposing of hypotheses, than is ingenuity of invention for framing them.

The facts and relations to which I have called your attention indicate the functions of the scientist in the present condition of our civilization. The duty of investigating the principles and laws of the material universe once conceded, this office devolves, in the grand division of labor, upon a special class. And that stage of progress is already attained, in which subdivision in a high degree, among this class, is imperative. Large acquaintance with kindred branches of science, and special concentration of effort upon a narrow field, are alike requisite for the investigator. Moreover he must be content with small and modest additions to human knowledge; humbly and hopefully gathering what he may, and bringing faithfully his sand-grains to the heap, if he find no stone for the temple. He may no longer look for brilliant discoveries as the sure reward of earnest research, though he should possess the genius of Pythagoras, Archimedes, or Copernicus; nor have others the right to expect it of him. And if perchance any such discovery or generalization fall to his share, simple justice demands that he concede to others much of the merit. The activity and energy of scientific inquiry at the present moment are intense beyond all precedent in history. The accretions and developments of a couple of years change the aspect and relations of each successive discovery almost past recognition. An important fact, noted but unpublished by one man, speedily manifests itself to others; so that suppressed discoveries are in fact abandoned ones, and the most important are very frequently made in duplicate. This is simply because the limit of our human knowledge spreads like a great circular wave, emanating from a center. The advancing lines have access only to what lies upon the margin before them, and the throng who press forward tread in contiguous paths, the divergence of whose radiation is overbalanced by the continually increasing number in the ranks. And it is characteristic of the present time that it is a period requiring co-operation and associated effort in scientific research, not merely for the sake of needful distribution of labor, but because combinations of resources and acquirements are requisite, to which no individual can attain.

It would be a grateful office to congratulate you upon the part our own people is taking in this great campaign for intellectual conquest. Thank God we may claim some part in it, and names too, among the living as well as the dead, which will surely gain lustre in scientific annals with the lapse of time. Yet how small is our relative share! Why have we not, in our forty millions of men, as many active investigators, as many scientific institutions, as much national support, as much popular sympathy, as may be found in Germany, France, or England? Why are the efforts of the scientist appreciated and encouraged solely in proportion to the estimate of them by popular and altogether incompetent tribunals? That it is so, needs no demonstration. Popular sympathy or encouragement rarely rewards the scientific investigator while living; and when it does, it is seldom because of his highest achievements. And those rewards, which the community honestly desires to bestow upon this class of intellectual labor, are but too apt to fall to the mere bookwright, if not to the charlatan. Meanwhile great public interests suffer for want of such guidance as very many easily might, and gladly would, give who live and die unrecognized by those who would desire to make their services available, and whose recognition would augment their usefulness a hundred fold.

Do you ask the remedy for this disease? I know none, except such change in public sentiment as may lead to deference, in scientific matters, to the judgement of experts, together with the maintenance and encouragement of institutions which may serve to develop experts and indicate who they are.

It cannot be denied that there is a large class with whom strong antipathies exist against scientific pursuits, and against those who are habitually engaged in them. For these prejudices there are various reasons, some by no means unnatural. That continual demand for evidence, which scientific studies evoke, is peculiarly distasteful to the vague and purely speculative mind, and affords a never-failing subject for ridicule. The very warfare in which the reverent votary of science sometimes finds himself involved in defence of her interests — so paramount in his estimation to his own — is made a ground for imputations of irritability and jealousy. The mere utilitarian objects to the abstractions of the higher sciences, as unfitting men for the daily duties of life; ignorant himself of any utility or duty which does not lie upon the surface. And then there is a counter-prejudice even among some educated and thoughtful men, which regards all studies pertaining to the physical universe, as of a low order and "materialistic" tendency, and which actually despises all inquiries, the correctness of whose results may be tested.

How far just foundation may exist for any of these adverse judgements, I will not undertake to say. There can be no doubt that exclusive attention to any one class of pursuits, will give onesidedness to the character, as well as to the culture; yet I am not sure that scientists are more justly subject to this criticism than any other class of men. Indeed it might be claimed for them, with a fair show of reason, that as a class, they are more familiar with literature, philosophy, and the arts, than the followers of these vocations are with science. Certainly they are better acquainted with the practical affairs of technology, than the so-called "practical man" is with scientific matters. And if the tenor of their studies lead them to distinguish sharply between what is, and what is not, susceptible of proof, and thus to lose some of the genial influences of imagination through their quest of the ennobling influences of truth, they may perhaps be thereby rendered less agreeable companions, yet they are none the worse citizens.

But all the opposition to scientific studies, springing from such considerations as I have named, is small compared with that from theological sources. From the very dawning of modern science, the various systems of theology have waged against it an unceasing war. The demonstrable character of its results have rendered it especially obnoxious to those who feared some encroachments upon their prescribed tenets, or who dreaded lest the overthrow of some favorite theory might be fatal to all reliance upon their creed. Some have assumed an antagonism between the orally and the visibly revealed word of God, and in their solicitude for the former have attempted to discredit the latter, and summoned to their aid the whole battery of the casuist. But they have forgotten that excess of zeal is abortive, whether it be in behalf of science or of religion, and is sure to create a reaction injurious to that cause in behalf of which it is exhibited.

I remember thirty years ago hearing a venerable and good man, who stood in the front rank of our scientific teachers, preface his lectures on geology with a deprecation of its "infidel" tendency when not properly interpreted. And the days are by no means past, when the efforts to reconcile apparently conflicting statements, in the book of Genesis and the book of Nature, are far more strenuous than any efforts at verifying the credentials of either statement. The inquisition of two decades ago took a different shape from that of two centuries earlier, but it was scarcely less tyrannous or unrelenting. That agony of nerve and muscle, which wrung from Galileo Galilei his transient recantation, was scarcely more severe than the mental and moral pangs, which more than one man of science has been called upon to bear in our own day, because he has become convinced that our earth existed thousands of centuries ago; that all mankind are not descended from a single pair; that the evidence is decisive that human beings lived during the pleiocene period; or that the sun antedated the earth, and its alternations of day and night.

All this is changed in our seminaries of learning today, I admit. In the meridian blaze of scientific knowledge, and the diffusion of its life-giving energy, such darkness could not continue. Yet how short the interval since its dispersion! Revulsions of popular feeling are like the oscillations of a mighty pendulum. Reaction has now in turn overshot its mark, and today it is theology which stands on the defensive. Even that attempted compromise, which would leave to scientists all things scientific, and to theologians all things theological, although in its nature unstable, has failed to find that temporary acceptance which might have been anticipated for it.

Thus the conflict, between accepted creeds and facts claiming to be demonstrable, is one which may no longer be delayed. No temporizing will avert it more, and one or the other must yield. Truth, though many-sided, cannot be discordant, and the honest man desires to know and to accept it. No evidence for any theory can be satisfactory, so long as evidence on the other side cannot be disposed of. The student of nature deals, it is true, only with material facts; yet his results, such as they are, are demonstrable, and may not be discarded to suit the preference of any sectarian. On the other hand, theological and philosophical inquiry deals only with moral evidence and with mind; yielding results which rarely admit of actual demonstration. With a strange avidity, the name 'science' is constantly claimed for researches in these fields, as though no other word were equally honorable; still it is relatively only a very small portion of them to which the term may be rightfully applied, since it implies the investigation, not of facts alone, nor doctrines, but of laws. And although unquestionably there have been, and may be, elicited in this field certain laws, yet their paucity is recognizable by the criterion that what is once established must be accepted by competent minds, and adopted as a basis for farther research. To deny the laws of gravitation, of the tides, of storms, of magnetism, is merely to manifest ignorance. Yet the multitude of diverse systems of philosophy and of religious creeds has been increasing, not diminishing, for the last two thousand years.

Still it may not be denied that we have two independent means of attaining knowledge of the higher truths. These imply totally different methods, and should reciprocally confirm each other, if their results be correct. Let the existence of a real conflict in their results be once established, and their is no escape from the inference that at least one of them is erroneous. Now although mistakes in scientific deductions are frequent enough, no sane man will contend that those results are erroneous, which may be proved to the acceptance of all competent investigators who examine the question. And those, who war upon all scientific investigation of theological questions, must either object to competent evidence, or must plant themselves upon the dangerous ground that all physical evidence is inadmissible.

In what I am saying I am sure no one will suspect me of the slightest intentional disrespect to the religious convictions of any earnest believer, however conservative or however liberal. Yet we are continually brought to the old, old dilemma, where science seems to demand one inference, and faith another. To accept either, if hopelessly contradicted, is repugnant to the philosophic mind; how to reconcile them, has been the problem of the ages. The apparent antithesis may be variously stated. One man presents it as between Nature and Revelation; the latter certainly divine, the former in its essence illusory. Another puts it as between Science and Religion; the former ignoring the moral, and the latter the perceptive faculties. A third gives it as between the evidence of the Senses and the intuitions of the Soul. Bigots, casuists, fanatics, have each in turn assailed the teachings of science, and have swept along with them many a good and earnest man whose fervid piety has led him to glory in the motto '*Credo quia impossibile est.*' Vague arguments, in which words and ideas have become almost inextricably confounded, have alarmed the consciences of men, lest the rewards of faith should be withheld from those whose faith required no sacrifice of reason. Meanwhile it has been forgotten, both that there must be some apparent reason for one's faith, and that faith and reason are alike expressions of the Divine in man. To such an intensity has bigotry continued even in our own days, that we may see the mischievous sophistry yet maintained in some quarters, that there are moral limits to inquiry, which man may not presume to transcend; before which scientific research is unlawful, and theological inquiry sinful. What could impel to such doctrine, except an apprehension of those results to which honest research might lead? Were the prohibition addressed only to a class deemed incompetent to investigate intelligently, or whose preliminary knowledge was inadequate, we might appreciate and possibly approve it. But this is not its spirit. It is either an assertion that the Almighty cannot guard his own secrets, or else it is an assertion that the All-wise and All-powerful has imbued us with quenchless aspirations, and has established incentives which cannot be followed without leading us away from him. Before modern science existed, while superstition held unchallenged sway, when dealers in the black arts of chemistry, astronomy, and the like, were conceded to have sold their souls to Satan, such a doctrine might not have surprised us. But that educated partisans of any creed should maintain today, that obedience to the God-given instinct of searching out the laws and being of the Almighty, in his physical and moral creation, is a crime, and that the tree of knowledge still bears fruit which it is forbidden to gather, in however reverential a spirit, seems a horrible anachronism.

If there be one moral truth which may be regarded as beyond all question, it is that our worship belongs to the author of nature, who fashioned alike the body and the soul of man, and is sovereign over all matter as well as all spirit. Yet the separation between scientific and religious views of the universe has been growing wider for a century, impelled by the joint efforts of the bigot and the atheist, who have worked most earnestly together for their common object. Never was the need so sorely felt for the discovery and recognition of that middle term, which must exist, and through which the dissonant views are reconcilable.

One of the clearest thinkers of our time believes that he has found such a middle term, and maintains with vigorous argument the doctrine that it exists in Force. And among its varied and correlated manifestations he claims that it nowhere finds a simpler or higher manifestation than in Will,—the only form which may claim to be primary. Here we enter upon a theme so lofty and so dizzying in its height that we may well distrust our powers; and in the unwonted keenness of our sense of their inadequacy, we feel how closely we are treading upon the margin of their range. Yet I will venture to say a few words upon this point, because I find myself alike unable to resist the conviction that a great verity underlies the idea, or to accept the doctrine as consonant with what may be regarded as demonstrated concerning the nature of force; notwithstanding the ability with which it has been maintained by a certain school of philosophers, that life, consciousness and all psychical energy are simply manifestations of this same force,—convertible into and deduced from heat, chemical action and the like.

Scientists are now of accord that "force can neither be created nor destroyed," and that "the quantity of force in nature is just as eternal and unalterable as the quantity of matter." Its various forms are eminently convertible, yet utterly indestructible. And to avoid that fruitful source of disagreement among the ablest men, which has arisen from the ambiguous signification of the word, we must adopt the meaning which is finding general acceptance, and define force as "that which is expended in producing or resisting motion;" thus clearly discriminating between force and its cause.

In his retiring Address before this Association, last year, our honored ex-president Dr. Barnard presented an argument, so vigorous and clear that I see no room for an adequate rejoinder, in opposition to the doctrine which would extend the principle of the conservation of force to the phenomena of consciousness,—"a philosophy which at the present day is boldly taught in public schools of science, and which numbers among its disciples many very able men." He says, for instance:—

> "Organic changes are physical effects, and may be received without hesitation as the representative equivalents of physical forces expended. But sensation, will, emotion, passion, thought, are in no conceivable sense physical."—[*Proc. Amer. Assoc., Chicago, p.* 89.]
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> "The philosophy, which makes thought a form of force, makes thought a mode of motion; converts the thinking being into a mechanical automaton, whose sensations, emotions, intellections, are mere vibrations produced in its material substance by the play of

physical forces, and whose conscious existence must forever cease when the exhausted organism shall at length fail to respond to these external impulses."—[*Ibid*, *p*. 91.]

"Thought cannot be a physical force, because it admits of no measure. . . . A thing unsusceptible of measure cannot be a quantity, and a thing that is not even a quantity cannot be a force."—[*Ibid*, *pp*. 93, 4.]

Before the cogent reasoning carried out by President Barnard, of which the general tenor is indicated by these quotations, the view that force affords a middle term between the moral and the material worlds can be sustained as little as the pure materialism against which the argument was directed. But if we ascend a grade higher, and consider that which guides and compels force, as force guides matter, I am disposed to believe that the problem may be nearer to a solution. Yet I offer my views with hesitance, not unmindful of the great thinkers who have considered these exalted topics, and shrinking from the rebuke of presumption.

There is an elegant experiment, in which the tension of a spring is made to produce heat by percussion, thus developing the current from a thermo-electric battery, which by successive modifications of its force exhibits heat, chemical action, magnetic attraction, and finally bends another spring; the same original force successively appearing in all these various manifestations until it is reëstablished in its primitive form. In such an experiment the imperfections of the apparatus would of course entail some loss at each successive step, and thus preclude the practical recovery of an available force equal to that expended in the original flexure of the spring. Yet the fact is beyond question that such loss is due solely to the inadequacy of our implements for collecting and transmitting the force at each stage of the experiment; for the law of conservation teaches that it is in every instance converted into other form or forms without diminution. Could such an apparatus be constructed with theoretical perfection, it would represent an eternal circuit of force; and, like the frictionless pendulum in a vacuum, it would exhibit a perpetual motion, after the needful impulse had once been applied. The spring would oscillate forever, did no extraneous force oppose, whether the force producing its rebound were or were not transmitted through a chain of modifications.

In this inert apparatus no force whatever would have been embodied, yet qualities would have been implanted by design, which would compel an indestructible force, applied to it, to play the part of an unwilling Proteus. The influence seems unavoidable that force may be guided and controlled, compelled to exert itself in this or in that shape, without the outlay of any other force for the purpose. If it be objected that it is an intrinsic law of force that it shall change its form in exerting itself, the case is in nowise altered by the expression of this truism. Our design has prescribed, and (extraneous force being absent) might indefinitely prescribe, the modes and directions in which that constant force should manifest itself.

Muscular force is directed, and in its vital action is usually controlled, by will. If we assume it to be coequal with the expenditure of tissue,* measurable alike by its transferred results and by the decomposition of this tissue, where and what is that power which lets loose or withholds this force, and whose action is attended by a conscious effort? It is the will, — a something which directs and controls force without expending it. Not only are thought and forms of consciousness not forces, if the reasoning already adduced be correct, but, although often moral incentives to the will, they are not even motive energies, in the sense in which I think we must concede the will to be such. It is true that the exercise of thought is followed by fatigue, yet it is not attended by a sense of effort, except in so far as it is directed by an exertion of the will. And although the former doubtless consumes tissue, have we any reason for believing that the exercise of will does the same, apart from that consumption which corresponds to the forces whose mode of action it prescribes?

Thus it would appear that the metamorphosis of force, though not "work done" in the mechanical sense, is the result of some definite mode of causation. What this causation is, and whether it is susceptible of measurement, are the next questions. In the same category with this agency, or energy, or influence, the vital principle would seem to belong, — directing forces while it neither expends nor consumes them. In the growth of organic beings, unstable combinations are formed, and organized structures are thence reared, in which, as Kant has so beautifully said, "all parts are mutually ends and means." If in such organic development force is consumed, disorganization without decomposition ought to evolve it. Of the deposit of force in the unstable material of the tissues, I am not speaking, but of the vitality itself, which represents an energy requisite for the development and growth of organisms, — their dissolution being in turn attended by development of inferior forms of life, which suggest that this energy may have again been made available, — an energy too which is not "force," as this term has just now been defined.

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* Even if it be also, to some extent, supplied by the disorganization of food not fully converted, the argument is not thereby affected.

No comparison can be drawn between vitality and those molecular forces which build the crystal. Crystalline forms arise when the molecular attractions enjoy the freest scope, and their construction must be attended by an evolution of force, which ought to be recognizable by physical tests, and which should also be measurable by an excess of their resistance to solution, over that of comparatively amorphous masses of the same material, in which equal weights present equal surfaces.

So, too, not only in that individuality which life confers and in the impossibility of insulating or transferring vitality, but also in its hereditary character and its apparent susceptibility of indefinite increase or diminution, the vital energy violates our fundamental conceptions of force, and demands a separate category, seeming to belong in the same with will. If will and life be forms of force, their total amount must be limited by the law of conservation. If, on the other hand, they are outside the realm of forces, we may more readily indulge the conviction to which experience would lead, that their freedom is unfettered by any restrictions within our knowledge, — each enjoying an indefinite, though possibly a correlated scope in its own domain. The indestructibility of both matter and force implies a fixed coefficient of force for matter in equilibrium; but how great is the contrast offered in this respect by such energies as life and will!

Now if this reasoning be correct, we may have in this class of energies that middle term, so earnestly desired and so intensely needful, which unites the phenomena of matter with those of spirit, and forms the connecting link between science and religion; their harmonious conjunction affording the highest system of philosophy. It is this class of energies which, controlling the forces of matter, guides and governs their modifications and transformations. It is this, moreover, which, inseparable from mind, is exerted by all conscious organism. The mystic play of coequal, but to our senses, so dissimilar forces, and the equally recondite mutual action of the eye, the brain and the nerve, alike demand agencies transcending all our science, yet implicitly obeying physical laws. The highest manifestations of these agencies is in will; the highest agent is the Almighty. Thus the dictum of faith, that the universe exists only by virtue of the continued will of its Creator, represents a palpable scientific fact; and we may see that the pantheist, the materialist and the spiritualist (I will not be debarred from this noble word by the associations of its misuse today) have been contemplating the same exalted truth from different aspects, with limited ranges of vision.

With the disappearance of theological hostility to science, a new era will commence, and increased progress may confidently be expected both for science and for religion. But we may not conceal from ourselves that the omens are less favorable for science in our own land than elsewhere, since there are peculiar obstacles to be encountered. These chiefly arise, directly or indirectly, from that characteristic in our national development, which assigns an exaggerated value to immediate utility, and a low estimate to what real utility is. It cannot be denied that the attainment of riches is becoming with us more and more the chief aim of existence; and this tendency is aggravated by that dominant spirit in our large cities, which gives to wealth alone the influence which it ought to share with integrity, with refinement, with education, and with talent. Thus the ambition of our youth is almost irresistibly directed to the acquisition of property as the highest worldly good, and their experience is made to confirm the doctrine. Our institutions of science, few as they are (and almost universally confounded by the public with institutions for the preliminary education of youth), are, like the latter, dependent upon subsidies and gifts from individuals. A disposition to advance the public welfare by liberal munificence, may certainly be claimed for our wealthy classes, and America has a right to abundant pride in the generosity of her rich men; yet it cannot be expected that largeness of views in literary or scientific matters should always be commensurate with largeness of heart; and the monuments of unwisely directed generosity, scattered all over the land, commemorate gifts, which, if judiciously bestowed, would probably have placed the United States in the front rank of intellectual progress. But, more than this, these same influences have resulted in placing, to a very large extent, the governance and guidance of intellectual agencies, and the control of intellectual institutions, in the hands of men not well fitted for their exercise. How could science, or literature, or art thrive, while their interests are in the keeping of those who do not comprehend them, and who, even with the best intentions, do not know at what to aim? The administration of the finances of an institution loses much of its value, when the institution itself goes adrift. And then again, while it has been and is still the usage to do all we can for the education of youth up to a certain point, no encouragement or support has been deemed needful beyond that point; so that in fact the individual is aided in preparations for usefulness, but receives not the slighest encouragement for the actual exercise of that usefulness, after the preparation is completed. In late years we have actually retrograded in this respect; and, even in seminaries of education, discouragements are thrown in the way of those studies which do not suit the views of the utilitarian. But in America today, the crying need is of opportunities to make serviceable such preliminary training as may have been acquired in any purely intellectual or scholastic field — a need far greater than any lack of opportunity to obtain this requisite education. It has become forgotten that the training of the school and the college is but a means, and not an end; and, as in so many other cases, the end is lost from sight in the pursuit of the means, — the prosecution of research is neglected, while the requisite education is zealously provided for. Thus it is that the scientist is compelled, almost without exception, to earn his bread independently of his vocation, that is to say, by work other than scientific research. Finally, the want of any recognized tribunal, whose judgement might be provisionally accepted upon matters requiring scientific knowledge for their decision, which might command public confidence by the character and attainments of its members, and which could represent, advocate and maintain the interests of science with the public and with government, has till recently been a source of disadvantage, which it would be difficult to overestimate.

The extent to which our people has indirectly suffered from the want of recognition and support of scientific pursuits would scarcely be credited at first statement. The lack of those mental habitudes which they imply, is a fruitful parent of superficiality, and is largely accountable for our national fault,—want of thoroughness ; for thoroughness will never flourish while only those pursuits are encouraged which promise immediate recompense of the most tangible sort. Another result is the absence of deference to competent authority, the absence of respect for mental excellence and power. To become aware how little we know, requires some progress in knowledge ; and, just as want of faith brings superstition, so disregard or ignorance of known laws begets credulity. What ludicrous illustrations of this fact are daily offered by the vague popular conceptions of the well-known laws of electrical action. I have heard it said that the most complex processes are suddenly revealed and made clear to the feminine mind by the magic word "machinery." Be this true or not, it will scarcely be denied that to the masculine intellect there is a cabalistic virtue of equal potency in the mysterious name "electricity." To this awe-inspiring agency — although no more recondite for the physicist than heat or light or gravitation — all uncomprehended facts are attributed with a sort of satisfaction to that reference to supernatural powers is thus evaded !

The recently prevalent belief in ghostly table-turnings, supernatural knockings, rappings and bell-ringings, and in spiritual lead-pencils, would furnish also a painful illustration of my meaning, were it not still a somewhat dangerous subject to discuss with freedom,—even out of Salem!

Prominent among the serious dangers which are theatening the welfare of science among us, at present, is its advocacy upon improper grounds. That man is no loyal follower and no true friend, of science who bases her claims to support upon the ground of immediate practical utility. How essential she always has been to the useful arts, all history and experience proclaim; yet these recompenses would form indeed a low and unworthy motive for her pursuit. To follow her for such an end would be to follow a Divine leader for the sake of the loaves and fishes, expected to be miraculously dispensed to hearers of the word. To hear that word, to learn that law, to gain some comprehension of the lofty scheme, such are at least the only motives worthy of avowal. The present reaction from the era, when all culture other than classical and metaphysical was disregarded if not despised, and the crusade against classical culture, which results from this excessive reaction, bode no good to science. The champions in this crusade occupy simply the utilitarian ground, and their alleged advocacy of science is in fact scarcely more than an advocacy of the useful arts as the highest object of education or of the attention of the educated classes. The crusade is not in behalf of this or that form of intellectual progress; it is against such intellectual culture as has not some tangible end, capable of being represented by dollars, or finding expression in some form of physical well-being. Results of this outburst of utilitarianism, combined with worship of Mammon, are already visibly manifested all around us in the substitution of expensiveness for elegance, of monstrosity for grandeur, of gaudiness for beauty, of quantity for quality. As the golden age degenerated to the iron, so the age of iron has dwindled into that of tinsel. See, in so many public buildings, how tawdry contrasts in color, or extravagance in ornamentation, usurp the place of beauty in form. See, in public grounds, how the grace and harmonies of nature are ostracized, for the sake of putting something expensive in their place. Even the reverence which would fain preserve and protect what is hallowed by associations and memories of the great and good is regarded as a conservatism, quite "behind the times."

To save our country from the abyss, on the verge of which it stands, will require all the energies which can be summoned; yet we have the satisfaction of knowing that, with few exceptions, the most refined and cultivated men of the land recognize the danger and are united in efforts for its aversion. Science has few stronger friends than among the scholars of America; scholarship, few more zealous adherents and admirers than among her scientific men. Intellectual culture, of any sort which aims at something higher than narrow utility, is what we need, and its advance in any one direction can scarcely fail to be followed by advances in others. Scientific education, moreover, peculiarly requires fullness of culture; and whatever hampers this, obstructs the progress desired. The experience of ages may not lightly be disregarded, and we must remember that novelty is not necessarily excellence in philosophy, education or art.

But there is a pleasanter side to the prospect; for, where science does have a foothold, her path is becoming smoothed and the sphere of her influence extended as never before. In scientific matters at least, we are attaining the epoch of simplicity, which entails universality, and this in its turn promotes the brotherhood of all who serve a common cause. The magnificent discovery of the correlation of the physical forces weaves the physical sciences into harmonious relationship, and opens to our vision glimpses of still grander generalizations beyond. Recognition of the equivalence of these different forces entails the introduction of absolute units which command universal acceptance; and thermic, electric, magnetic, chemic, mechanic energies are gauged by units depending on the meter and on the earth's rotation. The metric system of weights and measures, already of almost universal use for purpose of research, is rapidly finding popular adoption among all nations, notwithstanding the force of prejudice and the reluctance to modify habitual usage. Thus the nations are entering into more intimate intellectual relations with each other, at the same time that, by the progress of the arts of life, the physical barriers which separated them are broken down, and the sharpness of dividing lines is softened.

It would be unjust too, did we fail to acknowledge the influences by which trade has not unfrequently exerted a most healthful stimulus upon scientific research, when the requirements of the arts have pointed out the directions in which farther knowledge is especially needful for their purposes. The wonderful additions to our knowledge of the laws of electrical circuits, which have been evoked in England by the direct influence of companies for the manufacture and use of submarine telegraph-cables, furnish a brilliant example of what may be accomplished in this way. And of a quite analogous character are those national influences and characteristics which tend to the especial promotion of particular branches of science, and, by the reciprocal and reflected action of these upon the tendency thus implanted, render it markedly prominent. Thus the need of discovering and making manifest the mineral wealth of this continent, together with the magnificent fields offered for exploration, have given in America remarkable development and impulse to geological investigation, and the proportion of geologists among our scientific men is probably manifold larger than in any other country. The same may be said of physical geography and of geographical and topographical exploration. But, more than any other art, war has stimulated physical science; and those branches which have been made to contribute most abundantly to military ends are those which have thriven most among military nations. Applied mathematics and the departments of physics useful to the engineer, the topographer and the artillerist have specially flourished in France. An amusing illustration of the relative positions which sciences and arts may occupy under peculiar influences, is furnished by a publisher's book-list, published in Paris monthly. The newly published books are assorted by subjects, and one of the groups uniformly appears as follows: "*Sciences Mathématiques et Militaires:—Astronomie*, *Arithmetique*, *Marine*, *Equitation;*" thus showing how thoroughly the system of classification is arranged from the standpoint of the cavalry-man. National legislation, too, exerts a decided influence, and in our own land by no means a favorable one to the investigator. At this moment the import-duty imposed by law upon apparatus intended exclusively for investigation, in increasing the sum of human knowledge, is nearly three times as great as that upon the same apparatus if imported for purely educational purposes, in disseminating knowledge already attained!

In these remarks, Gentlemen, I have endeavored to lay before you such facts and considerations as may illustrate the position and relations of the follower of science, especially in the United States. What measure of confidence my inferences may deserve, your own experience and judgement must decide; but I am sure you will not doubt my earnest desire so to present them as to wound the sensibilities of no man. I have sought conscientiously to describe the present aspect of scientific culture in our country, neither shrinking from the statement of unwelcome truths, nor refusing admission to the hopeful promises of the future. What that future is to be, rests in great measure with the generation now upon the stage.

The magnificent, the stupendous march of scientific discovery in the recent past, leads to brilliant and almost limitless aspirations for the near future. The range of human insight into the creation has been of late so wondrously expanded at each limit, that we are emboldened to expectations of scientific discovery, which at first seem utterly extravagant. If within a decade we have learned to analyze the incandescent substance of sun and star, comet and nebula, — if we have attained to thermic, electric and acoustic tests, delicate beyond the apparent reach of human perception, — if we have learned the strange relation of meteor and comet, and added even molecular forces to the lists of known cosmical agencies, — if we have traced the laws of thermal refraction within conducting solids, and found out a higher alchemy in the transmutation of forces, — is it too much to expect that a few years more will disclose the subtle relation between conduction and induction; that whatever may correspond to refraction in electricity will be developed; that the source of the phenomena of terrestrial magnetism will be brought to light by the continued study of its laws; that the mystic bond of gravitation may be made less incomprehensible; that, if radiant action without a medium be possible, its mode of operation will be discovered; and that perhaps even the chemical constitution of the luminiferous ether may be analyzed.

In our own country, none of the obstacles to proper scientific development are insurmountable in their character. Serious they are indeed, yet far from discouraging. Amid our hopefulness and faith in the magnificent future which awaits the land we love more than Jews loved Zion, and toward which we look forward with an intenser pride than Athenian or Roman ever felt in the past glories of his country, we are too apt to tinge all the prospect with roseate coloring; and, in the greatness and depth of our confidence, we are tempted to shut our eyes to inauspicious omens. The patriot's duty is not to deny, but to meet and avert, all danger threatening his country; it is to labor for her welfare, not to bask in dreams of her coming glory.

There are already abundant indications of a desire in the community to encourage science. However large a share may have fallen by the wayside, or on stony ground, still much of the liberality already manifested must bear good fruit. And as the fruit ripens and the community receives the resultant benefit, many of the evils already enumerated must infallibly be diminished. That completely vicious circle of administrative policy must sooner or later disappear, by which, in institutions established for noble ends, the aims and objects themselves are lowered for the sake of winning donations for additional endowment. The time cannot fail to arrive when literary, artistic and scientific matters shall at last receive the guidance of literary, artistic and scientific men. Of all intellectual pursuits, our national character seems most inclined to those of science. Would that the prospects of classical culture and refinement were one-half as good as those of scientific progress; for the proper mutual relations once established, these could not fail to reinforce and supplement each the other. In short, we need only the adaptation of our hitherto untried forms of social organization to intellectual as well as material interests,—an adaptation, which the relatively small influence of intellectual pursuits thus far has too long delayed.

The fundamental idea of this Association is the Advancement of Science by promoting intimate relations among those who love and desire to serve her, by gathering from distant regions the various results of scientific study for common discussion and comparison, and by disseminating throughout the country a popular interest in the ennobling pursuits to which we offer our allegiance. The absurdity of casting ridicule upon the Association because it invites to its ranks all lovers of science, whatever their sphere of life, their attainments, or their avocation, — cordially welcoming the contributions and encouraging the attendance of all who avail themselves of this means of furthering the great end, — is only paralleled by that other one, which finds another occasion for ridicule in the policy of confining the decision of purely scientific questions to those who are scientists by vocation. The flippant sneers at scientific institutions of both classes, which not unfrequently meet our eyes, would almost lead us to doubt whether it were desired to confine all scientific culture to a class of Brahmins, or to submit the law of gravitation to a popular vote by majority. In the present critical period of our national development, the need of an organization like this is palpable; and, if only some element of greater stability and of established policy could be introduced (which would seem by no means difficult), its usefulness would be beyond description, reaching to every corner of the continent, and permeating the whole people with its healthful influence.

Our field, Gentlemen of the American Association, lies clearly mapped out before us. Our duties are shrouded in no uncertainty. To disseminate and impress the great truth that God has given us His works to read and His laws to learn; to advance the public estimation of scientific research, not as a means, but as an end, — an end, however, which when honestly pursued never yet failed to bring rich recompense to the community; to encourage and assist all institutions established for the increase of human knowledge; to inculcate respect for learning and reverence for authority; to guide ambition away from the mere accumulation of lucre and toward intellectual aspirations; to deserve the confidence and guide the liberality of good and patriotic men, who would contribute of their own abundance to further the holy cause of science; to protect scientific interests from the greed of those, who would make of them a prey, incited by the lust of money or of power; and by these and all other righteous means to hasten the time when the land of the setting sun shall become the Orient by leading the science of the world, awing the nations rather by her intellectual achievements than by her material power; — these are among the great interests which are committed to our charge.

May we, one and all, so acquit ourselves of these high responsibilities, that coming years shall render a verdict that the republic has received no detriment through negligence or weakness of ours!

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